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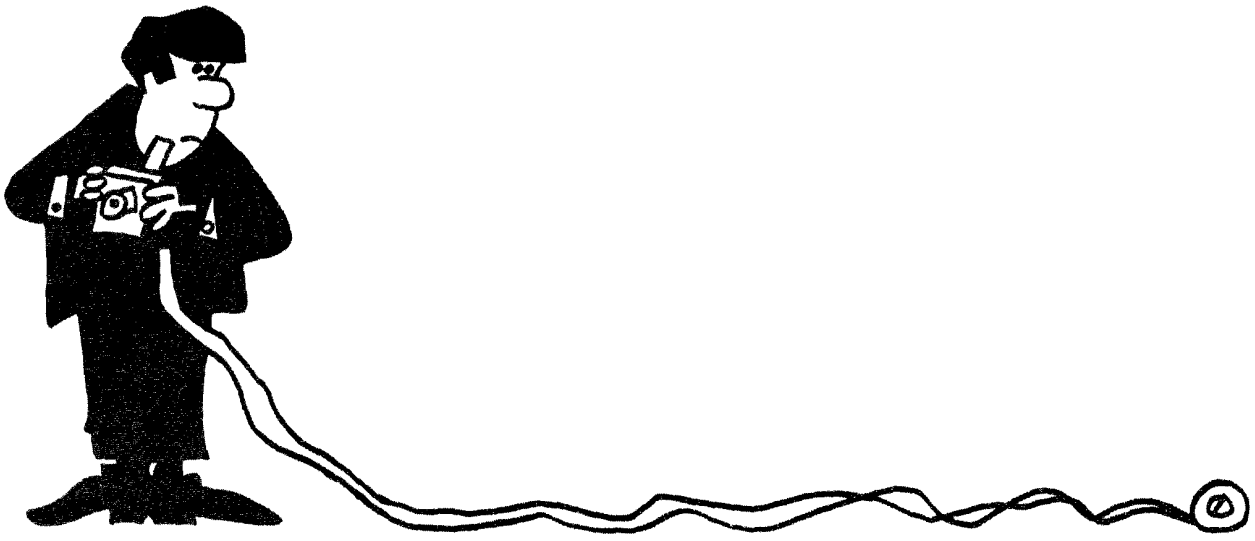

MAINTENANCE MANUAL FOR THE MINI-CAMERA MODEL I

NPIC/R-04/75
MARCH 1975

NATIONAL SECURITY INFORMATION
Unauthorized Disclosure Subject to Criminal Sanctions

Approved For Release 2001/08/13 : CIA-RDP78B04560A007400010037-4

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INTRODUCTION

There are three types of manuals for the mini-camera model I system:

1. Technical Manual--NPIC/R-10/74. This contains general technical information and operating instructions.

2. Maintenance Manual--the present document. This contains detailed information on the units which make up the system and on their maintenance and adjustment, particularly with regard to the special modifications provided by the system contractor. Also included is information on calibration and field tests and typical performance data.

3. Individual Equipment Manuals. These contain detailed information as furnished by the original manufacturer on individual equipment items.

As stated in the Technical Manual, the ability of the system to deliver high resolution is dependent upon the operator's full compliance with all rules and instructions. Included in this maintenance manual is information on field testing of:

1. Static performance of the hardware.

2. Dynamic performance of the total system including the operator.

These tests include the use of resolution targets in the field-of-view, providing a means of determining whether focus calibration has shifted and/or system performance has been degraded. System performance data is included.

Comments and queries regarding this manual or the system described are welcome. They may be directed to [redacted] 25X1A
25X1A [redacted] government code 143, extension 2476, or gray line extension 3821 (external number: area code 703, 351-2476).

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LIST OF EQUIPMENT

The mini-camera system (Figures 1 and 2) includes the following items:

1. Camera body, Nikon F, black.

2. 250-exposure motorized back, Nikon, individually fitted to the camera body and noninterchangeable unless refitted.

3. Four 250-exposure (33-foot) film cassettes.

4. Pistol grip, Nikon Model 41, with trigger, microswitch, and two integral connecting cords.

5. Battery pack with eight alkaline ''C'' cells and 44-inch cord.

6. Battery checker, Micronta 22-100.

7. Viewscope (sight) 4X, Swift Huntscope Model 722, modified by the addition of a mount and individually boresighted to the camera in the same system.

8. Viewscope (sight) 7X, Spiratone 350mm Teletach, modified by the addition of heavy crosshairs and a mount and individually boresighted to the camera.

9. Lens, 55mm-focal-length f3.5, Auto-Micro-Nikkor-P, modified by the addition of accurizer scales, magnifier, and worm-drive focus adjuster, with M-2 extension ring for use of the lens at 1:1 conjugates.

10. Telephoto lens, 180mm-focal-length f2.8, Auto-Nikkor-P, modified by the addition of accurizer scales, magnifier, and worm-drive focus adjuster.

11. Blower brush, lens cleaner fluid, and lens cleaning paper (50 sheets).

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13. *Focus calibration sheet.

14. *Operating manuals for camera, motorized back, pistol grip, and lenses and instructions for setting the combination lock on the attache case.

15. Attache case, Samsonite Classic 100, equipped with combination lock and foam lined.

The weight of the mini-camera system is 19 pounds.

EQUIPMENT USE, MAINTENANCE, AND ADJUSTMENT

CAMERA BODY

For motorized use the camera body is assembled into the 250-frame back. For conventional, nonmotorized use (camera is less bulky but also less capable) the camera body is removed from the motorized back (consult the Nikon manual for data on the motorized back) and installed in the original back, which is stowed beneath the camera in the attache case.

250-EXPOSURE MOTORIZED BACK

The 250-exposure back for the Nikon F camera is individually fitted to the camera body with which it is to be used. Malfunctions in the shutter or film transport may result if the back is used with the wrong camera. If such malfunction occurs with a properly matched camera body and back, they should be returned to the nearest Nikon maintenance center for adjustment.

*In the space behind the foam liner in the top half of the attache case.

250-EXPOSURE FILM CASSETTES

Damaged or improperly loaded film cassettes can cause total mission failure by preventing normal film transport.

New cassettes should be checked to determine that the inner shell rotates freely in the outer shell. If not, the interference can normally be eliminated by holding the outer shell in the left hand and rotating the inner shell inside the outer shell, back and forth through the interference area, under pressure of the right hand. Cassette parts should then be cleaned with a damp rag to prevent metal dust from getting into the camera.

Before loading with film, cassettes should always be checked for free rotation as above. Damaged cassettes should not be used.

In assembling and closing the cassette after loading it with film, it is important to turn the inner shell clockwise only to the latching position. Turning it too far will leave it unlatched or will capture a full turn of film between the inner and outer shells.

In installing the cassettes in the 250-exposure back, it is important to carefully follow the manufacturer's directions, making sure the cassette snaps into place with the index mark on it properly lined up. If the cassette can be rotated in its socket, it is not installed properly. (Pressure exerted by foam pads inside the rear cover prevents such rotation when the rear cover is closed.) If a problem becomes apparent at any time during the process of installing the cassettes and checking for proper operation, start over at the beginning.

The 250-frame motorized back can also be used with commercially available 36-exposure rolls of High-Contrast Copy or other films. This involves releasing two thumb latches, removing the camera body from the motorized back and loading the 36-exposure roll of film in normal fashion (refer to the Nikon motor drive and camera body manuals), and then reinstalling the camera body in the motorized back and operating the same controls as with a 250-frame load.

BATTERIES AND BATTERY CHECKER

The battery pack carries eight alkaline ''C'' cells. If alkaline cells are unavailable, ordinary carbon-zinc dry cells may be used. However, alkaline cells have longer life, more constant voltage, and better low-temperature performance. Batteries should be checked after returning from a mission, and replaced if weak. New batteries should be checked, especially if purchased overseas. Battery life depends on the duration and temperature of prior storage and on the mission conditions. The estimated life of ''C'' batteries used in the 250-frame motorized camera is as follows:

	Carbon-Zinc	Alkaline
Continuous use	1 roll (250 frames)	3-4 rolls (750-1,000 frames)
Intermittent use	5-8 rolls (1,250-2,000 frames)	10-20 rolls (2,500-5,000 frames)

PISTOL GRIP

Use of the pistol grip is essential to support very long lenses which might be used with the mini-camera. With the 55mm and 180mm lenses initially furnished, use of the pistol grip is optional. To avoid losing the top screw which serves as a quick-release stud, it should always be locked in the top of the pistol grip or screwed into the tripod socket of the camera lens.

VIEWSCOPES

Two monocular sights or viewscopes are furnished (Figure 3). The 4X Swift Huntscope is normally used at short range and in conditions where the target moves at a high angular rate relative to the camera. The 7X Spiratone 350mm monocular is used at long range, and especially with longer lenses (180mm and longer).

FIGURE 1. MINI-CAMERA PACKAGED IN ATTACHE CASE

FIGURE 2. MINI-CAMERA COMPONENTS

The 4X sight is fixed focus, and is in focus at distances of 50 feet or greater. The 7X sight has a focusing objective lens and can be focused at any range. The calibration on the objective lens can be ignored, the operator focusing visually through the sight.

Each sight has been fitted with a mount and boresighted to a line-of-sight parallel to the optical axis of the camera. The mount slides over dovetail ways below the camera rewind handle. The mount is fitted to the camera by tightening a wing bolt to pinch the mount so that it slides snugly onto the dovetail ways. If the ways should wear, the fit can be restored by tightening the wing bolt a small amount.

Reasonable care should be taken in installing and removing the sight, in order to avoid putting excessive torque on the dovetail ways of the camera.

> Caution: In normal use of a through-the-lens viewfinder camera like the Nikon F, it is impossible to leave the lens cap on inadvertently during photography. In using the mini-camera with a sight, there is a possibility of leaving the lens cap on. The user should develop a routine and a checklist to prevent this from happening.

LENSES

Description

Two lenses are furnished (Figure 4). The 55mm-focal-length f3.5 Auto-Micro-Nikkor lens gives outstanding performance at long and short ranges.* The 180mm-focal-length f2.8 Auto-Nikkor lens has an advantage of a 3.3 times greater focal length, although image-plane resolution is less than for the

*This lens was originally developed for close conjugate work. It can be used down to a 1:2 image-to-object ratio or down to 1:1 with the M-2 extension ring furnished with it. The optical design is such that the lens performs extremely well at long range as well as at short range.

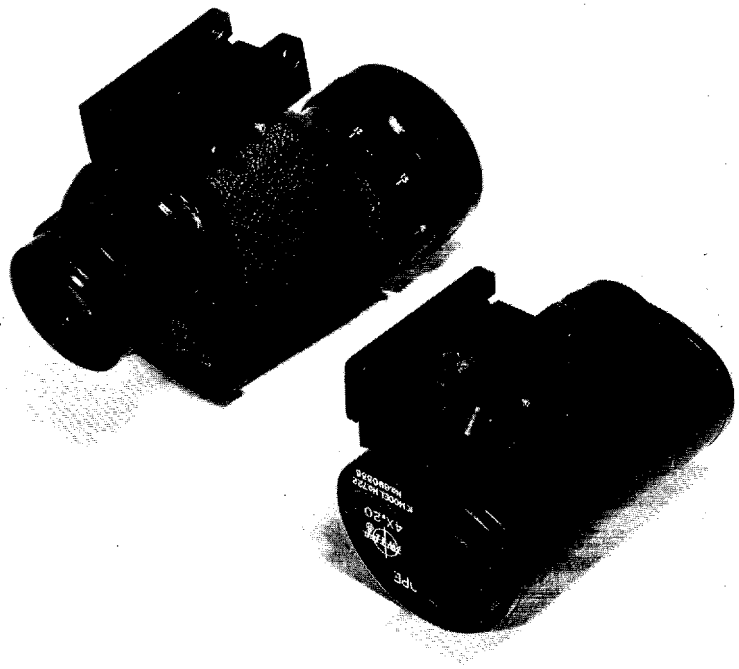

FIGURE 3. VIEWSCOPES, 7X AND 4X

FIGURE 4. LENSES, 180MM F2.8 AND 55MM F3.5, WITH FOCUS SCALES, MAGNIFIERS, AND FOCUS CONTROLS

55mm lens. For long-range photography the net effect of these two factors on target resolution is to give an advantage of better than 2 to 1 in favor of the 180mm lens if image smear is kept under control.

Focus Scales

Both lenses are equipped with precision photo-etched invar focusing scales. The stator scale has 40 equal divisions -- 20 on either side of zero-- at 0.004 inch per division.* The focus ring (rotor) of the 55mm lens is graduated at 10, 20, 50, 100, 200, 500-foot, and infinity-range values. The 180mm lens rotor is graduated at 50, 100, 200, 500, 1,000, 2,000 feet, and infinity. The scales are viewed through a 15X, f1.4, coated achromat magnifier permanently mounted to the lens barrel. In viewing the scales while focusing, the operator should use care to center his eye over the magnifier. Otherwise a parallax error of one-half to one division is possible. If it should become necessary, the scales can be cleaned by the blower brush or by a cotton ''Q-Tip'' dipped in alcohol, the operator taking care not to scratch the scales.

Focus Control

Focus is controlled by manually turning a spring-loaded worm drive** on the lower side of the lens while observing the focus scales through the magnifier. When the focus has been set, the worm drive locks the rotor in position against accidental movement.

*0.004 inch on the circumference of the lens represents a 0.00068-inch axial focus shift for the 55mm lens and a 0.00080-inch axial focus shift for the 180mm lens.

**For a left-handed photographer the worm and its flex shaft and knob can be reversed; care must be taken to replace the shims in their same positions under the flat spring which controls the pressure of the brass worm against the curved stainless steel rack. Epoxy should be applied to hold the screws in place. If the worm drive is reversed, clockwise rotation of the worm drive will move the rotor from left to right.

Caution: In order to avoid the effects of backlash in the threads internal to the lens, it is necessary always to start with the rotor scale to the extreme left (L-20 on the stator scale) as viewed through the magnifier, and turn the worm drive knob counterclockwise, bringing the proper rotor range mark to the calibrated stator index without overshoot. In case of overshoot, start again from the extreme left position.

Adjustment of Focus Control

At the time of original assembly the pressure of the brass worm against the curved stainless steel rack (Figure 6) was adjusted by the use of shims under the flat steel spring which presses on the worm shaft. If the pressure of the worm against the rack should be reduced, the worm drive will have backlash and may slip a thread at some point in its travel. If the pressure of the worm against the rack should be increased, it will become difficult to turn the focus control knob. In either case the problem may be corrected by removing the Phillips-head screw(s) which hold the U-shaped flat spring and cover plate in place (keeping track of the position of the shims) and reshimming to the desired pressure (that which allows free-turning operation over the full length of the scale without backlash). When the proper combination of shims is in place, the Phillips-head screw(s) should be fixed in place with epoxy glue. If the grease on the rack and worm becomes dirty, it should be removed with a solvent. The worm and rack can be relubricated by applying a strip of silicone grease to the rack.

Lens Use at Close Conjugates

To use either lens at distances closer than the minimum calibration, turn the focus control knob clockwise until the worm disengages from the rack. Then the focus ring may be rotated in the normal fashion to focus at any distance within the scope of the lens. To return the focus ring to the control of the worm drive, turn the focus ring until the rack contacts the worm. Then maintain a slight pressure between the rack and the worm while rotating the focus control knob counterclockwise until the worm and rack engage.

FIGURE 5. FOCUS SCALE AND MAGNIFIER

FIGURE 6. FOCUS-CONTROL WORM DRIVE

Lens Cleaning Aids

How do you clean an optical surface? Carefully! The 55mm and 180mm lenses, both sights, and the magnifiers on both lenses have coated optical surfaces which can be scratched in the process of cleaning. Dusty or smudged areas on the surfaces of the lenses and viewscope optics will be out of focus but will have little effect on imagery unless the sun is shining directly on the dusty or smudged surfaces. For this reason it will normally be better to leave minor smudges untouched. Dust can be blown and/or brushed off optical surfaces with the blower brush. Since most dust will scratch glass and lens coatings, the blower brush should always be used as the first step in cleaning. If necessary to go beyond this step, a drop or two of lens cleaner on lens paper can be used to remove smudges. The lens paper should be formed into a mushroom shape and held by the stem. Under no conditions should the finger be used to apply pressure to the lens surface directly through a layer of lens paper.

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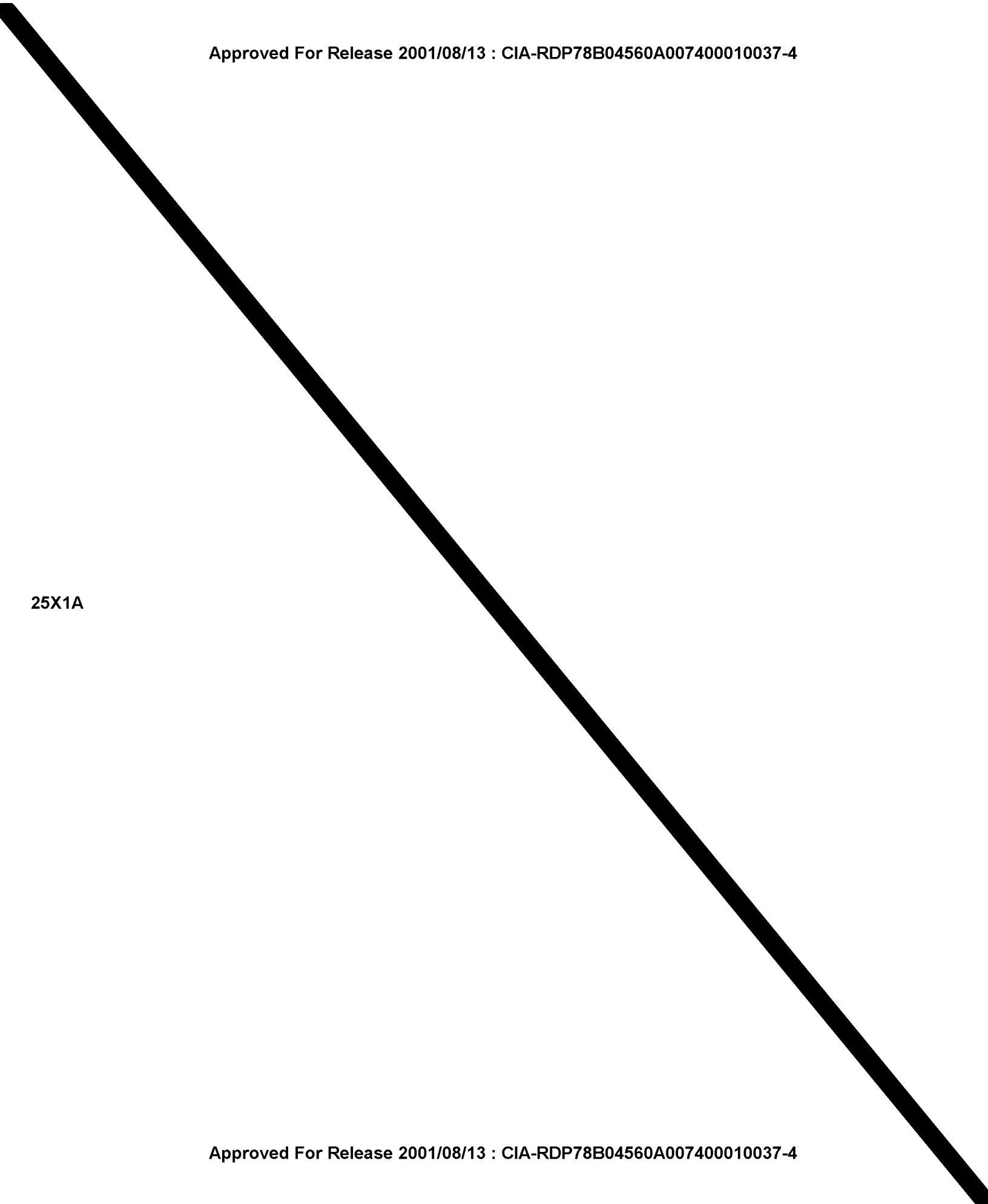
FOCUS CALIBRATION

Each mini-camera system is tested by the system contractor to determine the focus settings that will give maximum resolution. The focus calibration sheet* indicates the rotor and stator scale readings for best performance of the 55mm lens at target distances of 50 feet, 500 feet, and infinity,

*In the space behind the foam liner in the top half of the attache case.



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and of the 180mm lens at 50 feet, 1,000 feet, and infinity. The 55mm lens will normally be used at either infinity or 50 feet, and the focus calibrations discussed above will be sufficient for such normal operation. For situations involving the 55mm lens where the range is too short to use the infinity focus calibration, and where the range can be determined precisely, the precision focus settings of Table 2 can be used. Similarly, Table 3 gives precision focus settings for the 180mm lens. These data indicate that the 180mm lens should be focused one-half stator division to the left of the stator calibration for infinity, if the targets are between 4,500 and 20,000 feet away; one stator division to the left of the stator calibration for infinity, if the targets are between 3,000 and 15,000 feet away; and one and one-half stator divisions to the left of the stator calibration for infinity, if the targets are between 2,300 and 5,600 feet away.

EQUIPMENT OPERATING MANUALS

Manufacturer's manuals are provided* for the camera body, 250-exposure motorized back, pistol grip, and lenses. Instructions are also provided* for setting the combination lock on the attache case.

ATTACHE CASE

The system is contained in a Samsonite Fiberglass Classic 100 attache case with combination lock and instructions* for setting the combination. If needed, replacement foam is available from Ikelheimer-Ernst, 601 West 26th Street, New York, N. Y. 10001; area code 212, 675-5820.

AUTHORIZED MAINTENANCE SUPPORT

Depending on the nature of the malfunction or repair requirement, maintenance may be performed in the field or by either the original equipment manufacturer or the system contractor who made equipment modifications and assembled and tested the final hardware.

*In the space behind the foam liner in the top half of the attache case.

Table 2. Precision Focus Settings and Depth-of-Field for Intermediate Values of Range to Target, Using the 55mm f3.5 Micro-Nikkor Lens at Maximum Resolution (This data is for use where range to target is known -- that is, within the depth-of-field limits shown.)

Nominal Range (ft)	Rotor Index (ft)	Focus Settings (55mm Lens) Number of Divisions to Move Rotor Index to Left of Stator Calibration	Depth-of-Field* (ft) Near Field Limit	Depth-of-Field* (ft) Far Field Limit
50	50	0	47	54
55		1	52	60
61		2	57	67
68		3	64	76
76		4	71	85
86		5	80	97
100	100	0	91	113
120		1	105	138
150		2	124	184
200	200	0	160	268
300		1	218	440
500	500	0	320	840
840		1/2	420	1,000
∞	∞	0	840	∞

*There is an approximately 5% resolution loss at the near and far limits of the field.

Table 3. Precision Focus Settings and Depth-of-Field for Intermediate Values of Range to Target, Using the 180mm f2.8 Auto-Nikkor Lens at Maximum Resolution (This data is for use where range to target is known -- that is, within the depth-of-field limits shown.)

Nominal Range (ft)	Rotor Index (ft)	Focus Settings (180mm Lens) Number of Divisions to Move Rotor Index to Left of Stator Calibration	Depth-of-Field* (ft) Near Field Limit	Depth-of-Field* (ft) Far Field Limit
500	500	0	470	530
550		1	510	590
620		2	570	680
710		3	650	780
840		4	750	930
1,000	1,000	0	880	1,140
1,250		1	1,080	1,480
1,750		2	1,380	2,100
2,000	2,000	0	1,600	2,650
3,500		1	2,300	5,600
5,000		1-1/2 (1 division from ∞)	3,000	15,000
9,000		2 (1/2 division from ∞)	4,500	20,000
∞	∞	0	9,000	∞

*There is an approximately 10% resolution loss at the near and far limits of the field.

In view of the importance of maintaining system optimization, it is recommended that only minor maintenance and adjustment be attempted in the field (for example, adjustment of focus control, as described on page 10 of this manual). Problems with the pistol grip, battery pack, motorized back and cassettes, camera body, or shutter may be referred to authorized Nikon maintenance centers, preferably those in the US listed here: EPOI, 362 Stewart Avenue, Garden City, N. Y. 11530; EPOI, 7000 North Ridgeway, Chicago, Ill. 60645; EPOI, 501 Folsom Street, San Francisco, Calif. 94105; EPOI, 355 South Douglas Street, El Segundo, Calif. 90245. Problems involving the lenses, the sights, their modifications, or optimum system performance should be referred to [redacted] 25X1A

25X1A [redacted] government code 143, extension 2476, or gray line extension 3821 (external number: area code 703, 351-2476).

FIELD FOCUS TESTS

The mini-camera system is designed to provide a means by which the focus calibration and resolution performance of the system can be verified at any time in the field.

STATIC FOCUS TESTS

Because focus accuracy is critical to system performance and may change as a result of use, provision has been made for field focus calibration by means of a through-focus run, according to the following procedure:

1. Load the camera with film and mount it on a tripod from which a 30-pound weight is hung for stability. Lock the reflex mirror in the ''up'' position. Mount the 55mm lens on the body and set the lens for f3.5 at 1/1000 second.

2. Tape a wall target* to an east-facing tripod (or wall) so that it will be illuminated by the direct early morning sun.

3. Use the sight to point the camera so the target is in the center of the field.

*In the space behind the foam liner in the top half of the attache case.

4. Starting from a position well beyond L-20, turn the focus control knob counterclockwise until the 50-foot rotor index mark is at L-20 on the stator.

5. Expose one frame each with the 50-foot rotor index mark at L-20, L-19, etc., until the third division short of the 50-foot stator calibration mark (usually L-1, -2, -3, -4, or -5 for the 55mm lens and higher values for the 180mm lens), as specified on the focus calibration sheet. Expose three frames each for the next seven successive stator divisions. Expose one frame for each of the remaining stator divisions, ending at ''0''. In case of overshoot at any division, go back to the start position and rotate the focus control knob counterclockwise again to the desired point. This action eliminates the effect of backlash in the internal focus thread of the lens.

6. When the film has been processed, the target images will be read out to determine the best resolution in both directions for each frame. Plotting a curve of resolution in lines per mm vs rotor position will show the position in lines per mm (consult Table 1 for the wall target calibration).

7. A similar procedure is followed with the 180mm lens.

These static focus test can be run at any time when there is reason to believe the focus of the camera/lens combination may have shifted. To aid in determining the cause of below-standard mission imagery, it is recommended that an abbreviated through-focus test using the first 15 to 20 frames of the cassette be run prior to each mission, so that when the film is processed, the focus calibration can be validated for that mission.

Caution: After any through-focus run be sure to reset the focus for the expected operational use, starting from a position well beyond L-20 and turning the focus control knob counterclockwise until the desired rotor index mark is at the stator calibration point.

HAND-HELD TESTS

The ability of an operator to hold the camera steady can be verified at the time of the static focus test by having him use the camera, hand-held, to photograph the wall target at a 50-foot range, in one or more 15- to 30-frame bursts.

The ability of an operator to track a target from a moving vehicle can be verified by having him photograph the target in a 30- to 40-frame burst while being driven past it. A speed of 2.5 miles per hour at a range of 50 feet simulates the angular tracking rate of an auto traveling 25 miles per hour at a 500-foot range or of an airplane at 100 miles per hour at a 2,000-foot range.

PERFORMANCE DATA

The following performance data has been measured and/or computed for the optical components of the mini-camera I as an aid to the selection of lenses for any given mission.

LENS FIELD-OF-VIEW AND RESOLUTION

Table 4 indicates the field-of-view for each lens as a function of range. It also indicates the resolution goals for the best frame out of one or more bursts. The ability of the system to deliver such resolution can be validated by static focus tests discussed in previous paragraphs. Getting similar performance on occasional frames in hand-held tests is evidence of full operator proficiency.

Table 4. Best-Frame Resolution Goals and Field-of-View for 55mm and 180mm Lenses

Range (ft)*	Ground-Resolved Distance (Target Resolution) (inches)**		Field Width (ft)***	
	55mm	180mm	55mm	180mm
500	0.55	0.22	325	100
1,000	1.1	0.44	650	200
1,500	1.7	0.66	975	300
2,000	2.2	0.9	1,300	400
2,500	2.8	1.1	1,625	500
3,000	3.3	1.3	1,950	600
4,000	4.4	1.8	2,600	800
5,000	5.5	2.2	3,250	1,000
7,500	8.3	3.3	4,875	1,500
10,000	10.9	4.4	6,500	2,000
15,000	16.5	6.6	9,750	3,000
20,000	21.8	8.8	13,000	4,000

*These are slant ranges at altitudes between sea level and 5,000 feet barometric.

**Best frame, using High-Contrast Copy film, based on 200 lines per mm for a 55mm lens and 150 lines per mm for a 180mm lens, under best conditions. For mission planning, increase these values by the ratio of 3:2.

***Field in the 36mm direction of the format.

FIELD-OF-VIEW FOR VIEWSCOPES

Table 5 indicates the field-of-view for each sight as a function of range.

Table 5. Field-of-View for 4X and 7X Viewscopes

Range (ft)	Diameter of Field-of-View (ft)	
	4X Sight	7X Sight
500	73	62
1,000	147	124
1,500	220	186
2,000	293	248
2,500	365	315
3,000	440	372
4,000	586	496
5,000	730	620
7,500	1,095	1,116
10,000	1,470	1,240
15,000	2,190	2,232
20,000	2,940	2,480

These figures represent the following percentages of the field-of-view for lenses in the mini-camera I:

	4X Sight	7X Sight
55mm lens		
Vertical field	33.8%	28.8%
Horizontal field	22.5%	19.2%
180mm lens		
Vertical field	110%	93%
Horizontal field	73%	62%

Clearly, either viewscope will show most of the lens field when used with the 180mm lens. When either viewscope is used with the 55mm lens, the field-of-view is smaller than that of the 55mm lens. To insure proper coverage, center the target in the viewscope.

FULL-FIELD TARGET AREA FRAMING

Reflex mirror viewing can be accomplished without having the mirror operating during photography (which would degrade resolution). To obtain initial viewing of the target through the reflex mirror, move the mirror control to the ''down'' position and expose one frame to cause the mirror to come down for viewing. Then reset the mirror control to the ''up'' position and view the target. When the area of interest is properly framed in the viewfinder, note some feature at the center of the field, shift to the viewscope (sight), track the central feature, and take a burst of exposures. The mirror will go to the ''up'' position at the first exposure and stay up until the mirror control is next reset to the ''down'' position.

SUMMARY

This manual supplements the Technical Manual (NPIC/R-10/74) for the mini-camera model I and the individual equipment manuals furnished by the original equipment manufacturer. Detailed information has been presented on special features added by the system contractor, including information on maintenance, adjustment, and application of the equipment. It is hoped that this information will lead to the best possible performance under a variety of mission conditions.